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OPTICAL PROTECTING TAPE
[Kogakuyo protect tape]

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Claims /2*

1. An optical protecting tape characterized by having an adhesive layer on a part of a substrate comprising a thermoplastic synthetic resin film and containing a fluorescent substance, which is colorless and transparent under visible light but shows color upon ultraviolet ray irradiation.

2. The optical protecting tape of Claim 1, wherein the printing is carried out with fluorescent ink, which is colorless and transparent under visible light but shows color upon ultraviolet ray irradiation.

Detailed explanation of the invention

[0001]

Technical field of the invention

This invention pertains to an optical protecting tape used for protecting optical parts such as polarizing plates, etc., used in, for example, liquid crystal displays, light shielding films or lenses, etc. In particular, it pertains to an optical protecting tape that is transparent and enables easy determination of its applied position or its state of application.

[0002]

Prior art

The polarizing plate is an optical part absolutely required in a liquid crystal display. The conventional structure of the liquid crystal display polarizing plate consists of an iodine or dye-type polarizing element sandwiched between films made of triacetylcellulose (TAC) or acrylic resin.

* [Numbers in the margin indicate pagination of the original document.]

[0003]

To apply and affix easily on a liquid crystal cell, the above polarizing plate is frequently constructed as an adhesive polarizing plate with an adhesive layer formed on one side. Furthermore, such an adhesive polarizing plate has a mold-release film made of a thermoplastic synthetic resin attached to cover the adhesive layer for protection in many cases.

[0004]

On the other hand, coating layers for preventing diffuse reflection to inhibit flickering and providing scratch resistance are frequently installed on the opposite side of the adhesive layer, that is, the side that becomes the surface side when the adhesive polarizing plate is installed.

[0005]

In the liquid crystal display manufacturing process, the surface of the adhesive polarizing plate is generally protected from scratching, soiling, etc., with a protecting tape. This protecting tape is eventually removed, but to prevent scratching and soiling during the manufacturing process, a protecting tape with an adhesive layer showing excellent peelability is used.

[0006]

As a protecting tape, the typical example of the prior art was generally made of a low-cost polyethylene film as a substrate (Japanese Kokai Patent Application No. Sho 61 [1986]-133903). In recent years, a high level of transparency and homogeneity of the polarizing plate and adhesive layer applied on the polarizing plate has been strongly demanded because of trends of large size and high-density color liquid crystal displays. Especially, the tolerance standards have become stricter than ever in the case of optical

irregularity such as foreign objects, deformation, phase difference shift, etc., causing display defects. Therefore, the importance of a testing process examining any presence of optical irregularity in advance has been increased, and in the case of a protecting tape applied to the polarizing plate, homogeneity, transparency and cleanness are strongly sought.

[0007]

To satisfy the above demands, especially from the viewpoint of improving the accuracy of polarizing plate testing, the protecting tape of the prior art made of polyethylene film as a substrate has been replaced with a protecting tape made of polyethylene terephthalate film as a substrate (Japanese Kokai Patent Application No. Hei 7[1995]-26223, etc.)

[0008]

Problems to be solved by the invention

Compared with the previously used protecting tape made of polyethylene film, the protecting tape made of polyethylene terephthalate as a substrate has excellent transparency, homogeneity and scratch resistance, and consequently, the accuracy of polarizing plate testing is improved. However, because of very high transparency of the protecting tape made of polyethylene terephthalate film, there is a shortcoming of difficulty in determining at glance whether the tape is applied to the polarizing plate or not. Specifically, because of extremely high transparency and light transmission and advances in diffuse reflection-preventing measures, the determination of the tape being applied has become more difficult than ever.

[0009]

Furthermore, as described above, the side of adhesive polarizing plate with the adhesive layer installed has a mold-release film applied to protect the adhesive layer. This mold-release film is prepared with a polyester thermoplastic synthetic resin film as a substrate, and in the case of a protecting tape made of a polyethylene terephthalate film as a substrate applied on the surface side of polarizing plate, the same kinds of thermoplastic synthetic resin films are used in the two sides of the polarizing plate. Consequently, it becomes difficult to distinguish the front from the back in such an adhesive polarizing plate with the protecting tape applied becoming a cause of reducing productivity.

[0010]

To solve the above problem, there is a proposed method of applying a color to the protecting film by printing, etc. However in recent years, the inspection processes of liquid crystal display devices have become automated with automated inspection devices to standardize the inspection and improve the accuracy of inspection. These automated inspection devices to test liquid crystal display devices by detecting foreign objects, deformation, etc., and if the protecting film shows color, it may become a cause of erroneous detection. Therefore, if the protecting film shows color, it becomes difficult to use an automated inspective device.

[0011]

The objective of this invention is to provide a novel protective tape causing no difficulty in the case of automated inspection processes using automated inspection devices due to impaired transparency under visible light and at the same time, easily enabling detection of its application position and state with naked eye observation. /3

[0012]

Means to solve the problems

This invention has been successively carried out to accomplish the above objective, and it is characterized by being an optical protecting tape having an adhesive layer on one side of a substrate film and containing a fluorescent substance, which is colorless and transparent under visible light but shows color upon ultraviolet ray irradiation. The protecting tape of this invention is colorless and transparent under visible light, and in the case of applications to liquid crystal display devices, erroneous results occur only with difficulty as a result of automated inspection in an automated inspection process for detecting foreign objects, deformation, etc. In addition, this protecting tape shows color upon UV irradiation, and consequently, the application position and state of the protecting tape are easily detectable with naked eye observation.

[0013]

This invention is explained in detail as follows. As described above, the protecting tape of this invention is characterized by containing a fluorescent material that shows color in response to UV. As such a fluorescent material, it is possible to use any optional fluorescent material which is colorless and transparent under visible light but shows color upon UV irradiation, but it is preferably a fluorescent ink containing a fluorescent pigment absorbing ultraviolet rays but reflecting visible light.

[0014]

The above fluorescent ink contains an organic or inorganic fluorescent material, and depending on the specific component, fluorescence of blue, green, yellow, orange or red is emitted. It is possible to use a

commercially available fluorescent material that is colorless and transparent under visible light, and there are, for example, anthracene, chrysene, pyrene, quinazolone, porphyrin, etc., and dansyl dye.

[0015]

The fluorescent ink described above contains the above fluorescent material and resin component. The resin component consisting of fluorescent ink may be a resin that is transparent and suitable for dispersing the fluorescent material in it, and it may be selected from, for example, polyester resin, phthalate resin, styrol, methacrylate resin, vinyl chloride resin, etc.

[0016]

Incidentally, the protecting tape of this invention is characterized by containing the above fluorescent material, and it is preferably used in the form of fluorescent ink as described above, but the fluorescent material may be contained directly in protecting tape-constituting components such as adhesive, substrate, etc.

[0017]

If the fluorescent ink described above is to be used, it is preferably printed on the substrate because the application procedures are simple. More preferably, the fluorescent ink is desirably coated with a direct or reverse coater such as roller coater (including comma coater), gravure coater, knife coater, etc., on the surface of the substrate on the side having the adhesive layer prior to forming it by applying the adhesive.

[0018]

If the adhesive layer is allowed to contain fluorescent ink, the ink component may bleed to the optical film, for example, the substrate side of the polarizing plate, causing the optical characteristics of the optical film to change.

[0019]

On the other hand, if the fluorescent ink is printed on the surface side of the protecting tape substrate, the printed surface is exposed, the ability to emit fluorescence may be damaged, or an irregularity such as ink peeling or ink migration may become liable to occur due to friction or moisture in air, and thus, a protective layer is desirably installed outside of the fluorescent ink print layer. Incidentally, it is necessary to carry out the printing of the fluorescent ink so that there are no appearance defects or color formations damaging the accuracy of inspection under visible light.

[0020]

The printing pattern of the fluorescent ink may be on the whole surface of the substrate, or a continuous or discrete pattern of circles, dots or random dots may be printed, and furthermore, the printing may form characters. The thickness of the print of the fluorescent ink is not especially restricted, but if it is too thin, the coloration observed may be insufficient, making the detection of the protecting tape difficult, and on the other hand, if it is too thick, it may cause so-called anchor destruction, that is, peeling of the adhesive of the protecting tape from the substrate at the time of peeling of the protecting tape from the optical film. Therefore, the thickness of the fluorescent ink is desirably in the range of about 0.1-50 μm.

[0021]

Incidentally, the thickness of the fluorescent ink is not necessarily required to be uniform, and it may be partially variable. Furthermore, it is also possible to use multiple kinds of fluorescent ink to obtain compounded printing or prepare lamination, and as a result, it is possible to obtain fluorescence of multiple colors, further improving the distinguishability by naked eye observation.

[0022]

Furthermore, if specific patterns, symbols, characters, etc., are used at the time of printing of the fluorescent ink, it becomes possible to display, kinds, lot numbers, production date, etc., for the optical film such as polarizing plate, etc., adhesive or protecting film. If the amount of such information is relatively extensive, the information such as those items described above may be printed with the fluorescent ink, enabling prevention of any reduction in yield due to erroneous selection of materials or parts.

[0023]

In addition, the polarizing axis, etc., of the polarizing plate may be displayed with the fluorescent ink, and in this case, it is possible to eliminate any erroneous selection of the direction at the time of application and attachment of the adhesive polarizing plate with the protecting tape to the liquid crystal cell.

[0024]

In any case, the protecting tape of this invention is for carrying out distinction or identification with the fluorescence emitted upon UV irradiation, and the inspection ability is not damaged in the case of

automated inspection devices for carrying out inspection of shapes, presence of foreign objects, etc., under visible light.

[0025]

Furthermore, the ink layer formed with the fluorescent ink preferably has sufficient solvent resistance. Especially, in case the fluorescent ink is printed prior to installing the adhesive layer of the protecting tape, the ink may be eluted with the solvent in the adhesive causing color fading or reduced discrimination ability. To improve the solvent resistance, the resin component of the fluorescent ink may be cross-linked, and in this case, it is preferable because of a reduced possibility of the fluorescent material of the /4 fluorescent ink bleeding into the adhesive layer and contaminating the substrate side surface of the optical film such as polarizing plate.

[0026]

As a substrate of the protecting tape of this invention, it is possible to use a suitable thermoplastic synthetic resin film having excellent transparency and homogeneity. The film may be selected from, for example, those of polyester (such as polyethylene terephthalate, polybutylene terephthalate, polyethylene naphthalate, etc.), polypropylene, nylon, polyether ether ketone, polyphenylene sulfide, polystyrene, etc. From the viewpoints of costs and transparency, it is preferable to use a film of polyethylene terephthalate.

[0027]

In the production processes for display devices such as liquid crystal display devices and optical devices, the operations are generally carried out in clean rooms to prevent any contamination with dirt, dust, foreign objects, etc. In this case, antistatic treatment is preferably carried out for the protecting tape

so that no dirt or dust adheres to the tape. Furthermore, corona discharge treatment and easy-adhesion treatment are preferably carried out on the side of the substrate with the adhesive layer installed so that close adhesion to the adhesive layer is improved, and contamination with the adhesive of the polarizing plate due to anchor destruction is preventable when peeling the protecting tape.

[0028]

As an adhesive for forming the adhesive layer on one side of the substrate in the protecting tape of this invention, it is possible to use a suitable transparent adhesive showing easy peeling, and it is selectable from, for example, those adhesives prepared with acrylic, rubber or silicone type polymers as a base compounded with various additives such as plasticizer, softener, tackifier, antioxidant, filler, cross-linking agent, peeling force adjuster, etc. The acrylic type adhesive among them is especially suitable with respect to climate resistance, heat resistance, transparency and costs.

[0029]

The adhesive to be used is filtered to remove any dirt, dust and other foreign objects, and it is preferably coated on the substrate in a clean room. The coating of the adhesive on the substrate is carried out with a direct or reverse coater such as roller coater (including comma coater), gravure coater, knife coater, die, etc.

[0030]

Furthermore, if the adhesive used is a solvent-type or aqueous adhesive, the substrate with the adhesive layer coated is heated and dried after coating to allow the solvent or water to evaporate. Furthermore, the adhesive layer may be formed with a method other than those methods to use the solvent-type or aqueous

adhesives described above, for example, photopolymerization coating to coat a monomer or oligomer and carry out photopolymerization under a nitrogen atmosphere.

[0031]

As a specific method usable to coat the adhesive, there are, in general, direct coating on the substrate and transfer method on a separator first and subsequently transferring to the substrate.

[0032]

If the mold-release treatment is carried out on the back of the substrate, it is possible to use direct reeling with no separator. If no mold-release treatment is carried out on the back of the substrate, a separator is laminated after the adhesive layer is formed on the substrate before peeling. The protecting tape prepared as described is cut to a suitable size to prepare a protecting tape of the desired size.

[0033]

The protecting tape of this invention is used for protecting the surface of optical films such as polarizing plates, phase difference plates, etc., but it is also usable for protecting the surface of various other optical parts. As described above, the protecting tape of this invention is applied on the surface of optical films, etc., to protect the surface, and at the same time, it does not interfere with detectability during inspection to detect defective products, etc., because it is transparent under visible light. In addition, in spite of having excellent transparency, the protecting tape shows color upon UV irradiation, enabling easy confirmation of the application position and state with naked eye observation.

[0034]

<u>Application examples</u>

This invention is explained specifically in detail with application examples of this invention as follows.

<u>Application Examples 1-3 and Comparative Examples 1 and 2</u>

Substrate and adhesive

The substrate used was a 38 μm thick polyethylene terephthalate film (manufactured by Nimura Chemical Co., trade name: FE-2000, corona-discharge treatment on one side). The adhesive used was an adhesive solution prepared as a conventional acrylic adhesive by using a copolymer containing butyl acrylate/acrylic acid/2-hydroxyethyl acrylate in a ratio by weight of 96.5/2/1.5 and having a weight-average molecular weight Mw of 440,000 as a main component, dissolving at a solids content concentration of 30 wt% in ethyl acetate as a solvent and compounding 100 parts by weight of the solids content of the adhesive with 1 part by weight of a cross-linking agent (manufactured by Nippon Polyurethane Co., trade name: Coronate L-45) and 0.01 part by weight of cross-linking promoter (dibutyltin dilaurate manufactured by Kanto chemical Co.) as an additive.

[0035]

Adhesive layer formation method

In Application Examples 1-3 and Comparative Examples 1 and 2, the above adhesive solution was coated directly on one side of the substrate described above with a comma coater for a dried thickness of 25 μm after fluorescent ink printing or without any fluorescent ink printing, and the drying was carried out thoroughly in a hot air drying oven.

[0036]

Fluorescent ink used

As fluorescent material, Kayalite B (manufactured by Nippon Kayaku Co.) was used, and the resin component used was a polyester resin (manufactured by Toyo Boseki Co., trade name: Bylon 200). The mixing ratio of the fluorescent material and resin component was 1:100 by weight, the mixture of the fluorescent material and resin component was dissolved in a 1:1 mixed solvent of ethyl acetate/methyl isobutyl ketone at a concentration of 30 wt% to obtain fluorescent ink.

[0037]

Application Example 1

The fluorescent ink prepared as described above was coated directly on the corona discharge-treated side of the above substrate with a comma coater for a final thickness of 15 μm, and the drying was carried out thoroughly in a hot-air drying oven. The drying temperature was set at relatively low temperature of 80°C so that the fluorescent substance was not denatured. On the side of the substrate with the fluorescent ink printed, the adhesive layer was formed with the procedures described above in the adhesive layer formation method.

[0038]

Application Example 2

Subsequently after the steps of fluorescent ink printing and thorough drying in a hot air drying oven carried out as in Application Example 1, a polyester resin (manufactured by Toyo Boseki Co., trade name: Bylon 200) was coated as a protective layer for a final thickness of 3 μm directly with a gravure coater on the side of the fluorescent ink printed, and the hot-air drying was carried out under the same conditions as

those for the fluorescent ink printed layer. The surface of the substrate opposite the fluorescent ink print layer and above protective layer was treated by corona discharge, and the adhesive layer was formed with the procedures described above in the adhesive layer formation method.

[0039]

Application Example 3

The fluorescent ink was printed on the surface of the substrate similarly to Application Example 2, and after thoroughly drying, a polyester resin (manufactured by Toyo Boseki Co., trade name: Bylon 200) was coated for a final thickness of 0.5 μm directly with a gravure coater on the side of the fluorescent ink printed. Over the polyester adhesive of the substrate, the adhesive layer was formed with the procedures described above in the adhesive layer formation method.

[0040]

Comparative Example 1

The adhesive layer was formed with the procedures described above in the adhesive layer formation method on the corona discharge-treated side of the substrate.

[0041]

Comparative Example 2

On the corona discharge-treated side of the substrate, color ink (manufactured by Dainippon Ink Co., trade name: Ultima No. 402, yellow) was directly coated with a gravure coater for a final thickness of 15 μm, and the drying was carried out thoroughly in a hot-air drying oven. Over the color ink printed

layer, the adhesive layer was formed with the procedures described above in the adhesive layer formation method.

[0042]

Evaluation

For the protecting tapes prepared in Application Examples 1-3 and Comparative Examples 1 and 2 as described above, the transparency, appearance inspectability and application position detectability were evaluated according to the following procedures.

(1) Transparency: light transmittance of white light was measured.

(2) Appearance inspectability: many dots of 50-200 μm diameter were formed with black ink on the polarizing plate, the protecting tape was applied over them, and the extent of observable size of the black dots was confirmed with naked eye observation.

(3) Application position detectability: after application to a polarizing plate, the protecting tapes of Application Example 1-3 were evaluated with UV irradiation from a chemical lamp having a median wavelength of 330 nm for ease of distinction or identification of the front and back of the polarizing plate (that is, the recognition and identification of the side with the protecting tape applied) by carrying out naked eye observation. Incidentally, for Comparative Example 1, the ease of recognizing and identifying the front and back of the polarizing plate was similarly evaluated without any UV irradiation. Furthermore, for Comparative Example 2, the evaluation was carried out similarly with respect to the recognition and identification of the front and back of the polarizing plate by carrying out white light irradiation.

[0043]

The results of the evaluation are shown in Table 1 as follows. Incidentally, the number shown in the appearance inspectability column of Table 1 is the minimum detectable dot diameter with naked eye observation.

[0044]

Table 1

	Transparency	Appearance inspectability	Application position detectability
Application Example 1	82	50	Easy
Application Example 1	82	50	Easy
Application Example 1	82	50	Easy
Comparative Example 1	83	50	Difficult
Comparative Example 2	65	150	Easy

[0045]

As apparent from the results shown in Table 1, the protecting tapes of Application Examples 1-3 showed the same excellent transparency as that of the protecting tape of Comparative Example 1. Furthermore, in the protecting tapes of Application Examples 1-3, the front and back of the polarizing plate or side with the protecting tape applied was easily recognizable upon UV irradiation because of pale yellow fluorescent emission from the protecting tapes.

[0046]

In contrast, the detection of the side of the polarizing plate with the protecting tape of Comparative Example 1 applied was difficult in spite of excellent transparency of the protecting tape. For Comparative Example 2, the protecting tape applied on the polarizing plate was easily recognizable under white light, but the results with respect to transparency and appearance inspectability were significantly inferior to those of the protective tapes of Application Examples 1-3.

[0047]

Application Examples 4-6 and Comparative Examples 3 and 4

In Application Examples 4-6 and Comparative Examples 3 and 4 as follows, no adhesive layer was installed, and the difference of the presence of the fluorescent ink layer was evaluated with the substrate of the protecting tape alone.

[0048]

Application Example 4

On the corona discharge-treated surface of the same polyethylene terephthalate film as that used in Application Example 1, the same fluorescent ink as that used in Application Example 1 was coated directly for a final thickness of 40 μm with a comma coater, and the drying was carried out thoroughly in a hot-air drying oven. Incidentally, the drying was carried out at relatively low temperature of 80°C so that

/6

the fluorescent substance was not denatured.

[0049]

Application Example 5

The same procedures as those in Application Example 4 were carried out except that the final thickness of the fluorescent ink layer was set at 15 μm to obtain a substrate.

[0050]

Application Example 6

The same procedures as those in Application Example 4 were carried out except that the final thickness of the fluorescent ink layer was set at 5 μm to obtain a protective tape substrate.

[0051]

Comparative Example 3

Similarly to Comparative Example 1, the polyethylene terephthalate film (with a corona discharge treatment on one side) was used.

[0052]

Comparative Example 4

On the corona discharge-treated side of the same polyethylene terephthalate film as that used in Application Example 1, color ink (manufactured by Dainippon Ink Co., trade name: Ultima No. 402, yellow) was directly coated with a gravure coater for a final thickness of 15 μm, and the drying was carried out thoroughly in a hot-air drying oven.

[0053]

Evaluation of Application Examples 4-6 and Comparative Examples 3 and 4)

For the protecting tape substrates prepared as described above, the transparency, appearance inspectability and detectability were evaluated according to the following procedures.

(1) Transparency: light transmittance of white light was measured.

(2) Appearance inspectability: many dots of 50-200 μm diameter were formed with black ink on the same 38 μm thick transparent polyethylene terephthalate film as that used for the substrate, the substrate was applied over them, and the extent of observable size of the black dots was confirmed with naked eye observation. The smaller the detectable dot, the better the appearance inspectability.

(3) Detectability: on the same 38 μm thick transparent polyethylene terephthalate film as that used for the substrate, 10 cm square pieces of the protecting tape substrates were applied and evaluated for recognition and identification of the presence of the protecting tape substrates. For Application Examples 4-6, the evaluation was carried out with UV irradiation from a chemical lamp having a median wavelength of 330 nm. Furthermore, for Comparative Example 4, the evaluation was carried out similarly with respect to recognition and identification with white light irradiation.

[0054]

The results of the evaluation are shown in Table 2 as follows. Incidentally, the number shown in the appearance inspectability column of Table 2 is the minimum detectable dot diameter by naked eye observation.

[0055]

Table 2

	Transparency	Appearance inspectability	Detectability
Application Example 4	84	50	Easy
Application Example 5	87	50	Easy
Application Example 6	88	50	Easy
Comparative Example 3	88	50	Difficult
Comparative Example 4	69	150	Easy

[0056]

As apparent from the results shown in Table 2, the protecting tape substrates of Application Examples 4-6 showed excellent results for transparency and appearance inspectability, and thus, the transparency was found to be as high as that observed in the previously available product. Furthermore, the protecting tape substrates applied on the PET film were easily recognizable upon UV irradiation with naked eye observation because of pale yellow fluorescent emission from the protecting tape substrates.

[0057]

In contrary, for Comparative Example 3, the substrate on the PET film was difficult to recognize by naked eye observation in spite of excellent transparency. Furthermore, in Comparative Example 4, the substrate on the PET film was easily recognizable, but the transparency and appearance inspectability were poor, and thus, the transparency was low.

[0058]

If the adhesive layer is formed with a suitable method on the substrates of Application Examples 4-6, it is apparently possible to prepare protecting tapes that have excellent transparency and are easily recognizable for their application positions upon UV irradiation.

[0059]

Effect of the invention

According to this invention explained above in detail, the protecting tape contains a fluorescent material, and consequently, the protecting tape of this invention shows color upon UV irradiation in spite of sufficient transparency under visible light, enabling sure recognition and identification of its application position by naked eye observation. Furthermore, because of excellent transparency, any poor appearance or defect of optical parts such as polarizing plates, etc., is detectable with the protecting tape of this invention applied, and at the same time, it is difficult to generate any erroneous result in the case of an automated inspection device used, and thus, the inspection accuracy is not damaged.

[0060]

In addition, because of fluorescence emission upon UV irradiation, the state and position of the protecting tape application are easily detectable, enabling the prevention of any omission to remove the protecting tape and furthermore, making the peeling procedure itself easy.

[0061]

Furthermore, the inclusion state of the fluorescent material may be suitably selected, for example, ink containing the fluorescent material may be printed to provide information in the form of characters, etc., enabling the display of the kinds of optical parts such as polarizing plates, etc., adhesive or protecting tape

used, date of preparation, lot number, polarizing axis, etc. Therefore, the material selection and confirmation operation can be carried out easily without any errors. Consequently, it is possible to improve overall productivity of optical devices or liquid crystal display devices, and it is possible to reduce production costs.